

Western Canal
South side of Salt River
Mesa,
(Tempe,
Phoenix)
(Maricopa) County
Arizona

HAER No. AZ-22

HAER
ARIZ,
7-MESA,
1-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
Western Regional Office
National Park Service
U.S. Department of the Interior
San Francisco, California 94102

HISTORIC AMERICAN ENGINEERING RECORD

HAER
ARIZ,
7-MESA,
1-

Western Canal

HAER No. AZ-22

NOTE: This report includes the written documentation for the Highline Canal (HAER No. AZ-23). See the report for photodocumentation of the Highline Canal.

Location: On the south side of the Salt River, in the city limits of Mesa, Tempe and Phoenix, Maricopa County, Arizona

UTM: Head - 1414491.792E/1119225.680N
Foot - 1311760.530E/1122525.2N

Date of Construction: 1911-1913

Engineers: U.S. Reclamation Service
Supervising Engineer: Louis C. Hill
Project Engineer: C. H. Fitch

Present Owner: United States Government; administered by the Salt River Project

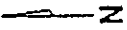
Present Use: Conveys water for agricultural, industrial and municipal uses.

Significance: The Western Canal expanded the irrigable acreage of the Salt River Project; constructed partly by the Reclamation Service and partly by the landowners to be served; supplied water to the Highline Pumping Plant and Canal.

Historian: Fred Andersen
Salt River Project Archives



SCALE
0 2 4 MILES



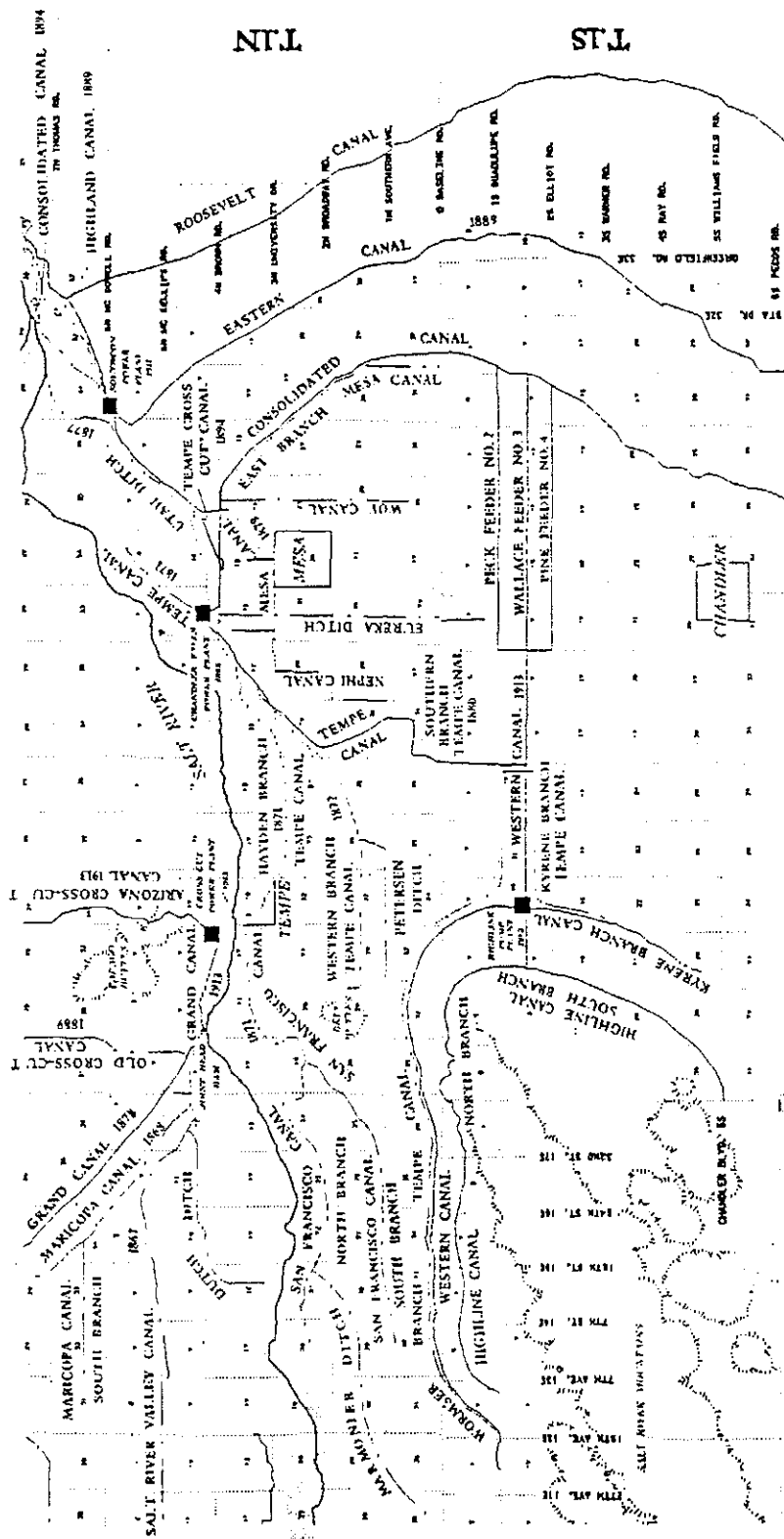
CANALS OF THE SALT RIVER VALLEY (PAST & PRESENT)

LEGEND

HISTORICAL CANAL

EXISTING CANAL

POWER PLANT/
PUMPING PLANT



R.6E

R.5E

R.4E

R.3E

IRRIGATION IN THE SALT RIVER VALLEY

In prehistoric times, the Salt River Valley was extensively irrigated by Hohokam Indians, who dug hundreds of miles of ditches leading out of both banks of the Salt River to water their farms. The Hohokam may have operated and extended their system for over 500 years, but sometime between the 13th and 15th centuries, they left the area, for reasons unknown to history. Where they went is also unknown. When Anglo and Mexican settlers began to arrive in the valley in the second half of the 19th century, there were no Indians occupying the area, but many of the ancient canals of the Hohokam were still visible.

In 1865, Camp McDowell was established at the eastern end of the Salt River Valley as part of a military effort to contain marauding Apache Indians. The army post not only made settlement in the valley safe for the first time, it provided an economic reason for farming: the mounted troops needed a local source for hay and grain. Like the Hohokam, and the Pima Indians who had extensive irrigation works nearby on the Gila River, the Anglo and Mexican settlers dug ditches to water their farms. In 1868, the first permanent canal in the valley was dug by a small group of settlers led by Jack Swilling. Swilling's Ditch, later known as the Town Ditch and the Salt River Valley Canal, came out of the north bank of the river just south of the Pueblo Grande Indian ruin, and proceeded west and northwest through what would become the early Phoenix townsite, and later, downtown Phoenix. By 1870, the population of Phoenix had grown to 240 persons, farming 1,500 acres of land. Other small ditches had been taken out on both sides of the river. (1)

The Tempe Canal, begun in 1871, was the first permanent canal taken out on the south side of the Salt. It headed some seven miles upriver from Hayden Butte and soon watered most of the land in the area around the Tempe townsite [see map, p. 2]. The San Francisco Canal headed just downstream from Hayden Butte and branched out to irrigate up to 4,000 acres south of the river and west of tempe. By 1874, the San Francisco Canal was receiving almost all of its water from the tailrace of the Hayden Mill, a branch of the Tempe Canal system. The Tempe system gradually extended to the south and west over the next three decades, and served much of the area which would eventually come under the Western Canal. The Wormser branch of the Tempe Canal ran west across the northern part of Township 1 South, Range 3 (T1S, R3E), then followed the contour of the land to the northwest around the base of the Salt River (South) Mountains. This canal took water to the lands of Michael Wormser, who also owned the San Francisco Canal and most of the land under it. The Wormser branch may have been built as early as the mid-1870s, and certainly by the late 1880s, most of the land in the southwestern sections of Township 1 North, Range Four East, and those in the northeastern part of Township 1 South, Range Four East, were being irrigated from the Wormser branch. This canal may also have been interconnected with the

1 Geoffrey P. Mawn, "Phoenix, Arizona: Central City of the Southwest, 1870-1920," (Ph.D. dissertation, Arizona State University, 1979) p. 17.

San Francisco through a north-south crosscut. The Kyrene or Orange Belt branch of the Tempe Canal ran west through sections 12, 11 and 10 (T1S, R4E), about one-half mile south of the Wormser branch, then turned to the southwest and followed the contour of the land in that direction. New lands under this canal opened up in the late 1880s through 1907. The Tempe Irrigating Canal Company was an unincorporated association which maintained the dam and the main canal, and the farmers under each bridge of the canal system also formed companies to dig and maintain the branch canal. Thus, landowners under the Kyrene branch had shares in the Tempe Irrigating Canal Company, and also in the Orange Belt Canal Company. The Wormser and the Kyrene branches of the Tempe Canal were precursors of the Western Canal, located in approximately the same place, and irrigating many of the same lands. (2)

THE KIBBEY DECREE

As settlement of the valley increased, so did the number of canals and water rights claims, until the water claimed from the Salt River amounted to several times its annual flow. This was worrisome to the more established farmers, such as those under the Tempe and San Francisco canals. Under the customary system known as prior appropriation, a diverter could take from the river as much water as he needed to grow his crops or use for some other purpose, such as running a mine or a water wheel. Diverters were supposed to be ranked by date of appropriation, so that in times of shortage, the earliest appropriators were assured that they would have first claim on any water in the river. Thus, the water rights of the early farmers were extremely valuable, but only if they could be enforced against junior appropriators. Although custom and territorial law supported the principle of prior appropriation, there was no system for regulating diversions or enforcing prior rights. Water appropriations were posted on river banks and in the county recorder's office, but since there was no accurate way of measuring the water in the river, upstream diverters tended to take as much water as they needed, without regard for senior rights downstream.

As upstream diversions increased in the 1880s, many of the downstream diverters began to feel that their water supply was being preempted by junior appropriators upstream. This sentiment became especially keen after the Arizona Canal Company made a claim for 50,000 inches of water and built a diversion dam above all the other dams, near Granite Reef. In February 1887, most of the canal companies joined in a suit to prevent the Arizona Canal Company from diverting their claimed water. Over the next three years, the Arizona Canal Company bought controlling interest in each of the northside canal companies, and most of the southside companies dropped out as plaintiffs. By the time the trial began in March 1890, only the Tempe Canal Company and Michael Wormser (sole owner of the San Francisco Canal and a major stockholder in the Tempe Canal) were left

2 "Decision and Decree," Hurley v. Abbot (No. 4564, Third District Court, Maricopa County, Arizona Territory, 1910) Table No. 3, pp. 42-48.

as plaintiffs, while all the other companies had become defendants. The case is therefore known as M. Wormser et al v. Salt River Valley Canal Company et al. The case was heard by Judge Joseph H. Kibbey in the Third Judicial District Court, Maricopa County. The decision was rendered in April 1892, and the accompanying decree was made in October 1892.

This was the first important water rights case in Arizona, as it established most of the critical principles of the State's water law. First, Judge Kibbey held that only owners and occupants of land were entitled to appropriate water, and a right could only be established by appropriation and use of water on the land. Second, he upheld the custom of priority of rights based on date of appropriation and more or less continuous use. Third, he decided that canal companies were common carriers of water and could not themselves own water or water rights, and that the sale of water was not a use of it. Fourth, Kibbey held that the right of appropriation of water was permanently appurtenant to the land which it irrigated, and that the ownership of stock in a canal did not in itself amount to a water right.

Despite the importance of the legal principles established, the Kibbey Decree had only one immediate effect on water distribution in the valley. This was to assure the water supply of the Tempe and San Francisco canals as against all the other major canals. Before the decree had even been entered, all the defendant companies had joined in a contract to share and divide all the water not required for the Tempe and San Francisco canals. Thus, the principal function of the court water commissioner, appointed by Kibbey, was to designate the supply for these two canals. The Tempe Canal was assured of a water supply for 117 quarter-sections in times of plentiful supply, and 95 quarter-sections had an appropriation date prior to 1885, when the first appropriations under the Arizona Canal were recognized. (3)

That this system did not work to the detriment of the Tempe and San Francisco canal owners may be inferred from the assertions of a contemporary observer that the contract dividing the waters among the other canals "does not represent the wish of the majority of the water users under the (other) canals," and was the "cause of much litigation." Meanwhile the operating conditions of the Tempe Canal during the 1890s were described as being "as satisfactory as under any large canal of the Valley, and much more satisfactory than under most of the other canals." (4)

FORMATION OF THE SALT RIVER VALLEY WATER USERS' ASSOCIATION

In 1890 and 1891, great floods came down the Salt River, washing out the primitive dams and headgates of the canal companies. Then, for the next fifteen years, a prolonged drought was interrupted only by an occasional destructive flood. The solution to the problem of controlling the

3 Ibid., pp. 5-7.

4 Alfred J. McClatchie, "Utilizing Our Water Supply" (University of Arizona Agricultural Experiment Station Bulletin No. 43, 1902), pp. 82-89, 92.

river and increasing the water supply was a storage dam and, through the 1890s, the people of the valley debated how to organize and finance this tremendously expensive project. The Tonto Basin dam site had been located in 1889, but neither private companies nor local governments had the resources to build the dam. During this period, the national reclamation movement, which should federal financing of irrigation projects, was growing in strength and developing a consensus on principles for the necessary congressional legislation. When Theodore Roosevelt succeeded to the presidency upon the assassination of McKinley in 1901, he strongly supported federal reclamation. The passage of the Reclamation Act of June 17, 1902, meant that selected projects would be built and financed by the U.S. Reclamation Service (USRS). Valley residents were very hopeful that the Tonto site would be among the first projects built, since U.S. Geological Survey engineer Arthur P. Davis (later chief engineer and director of the USRS) had already described the Tonto project as one of the most ideally situated in the West in terms of the storage capacity of the reservoir, the fertility of the irrigable land and the climate of the area. (5)

In August and September of 1902, the farmers of the Salt River Valley formed a Water Storage Committee to negotiate with the Interior Department, and to push for the early approval of the Tonto dam. The Water Storage Committee named Judge Joseph Kibbey to write articles of incorporation for the Salt River Valley Water Users Association, which would represent the interests of all the farmers, guarantee repayment for the dam, and operate the completed irrigation system. The articles were presented to the executive committee of the Water Storage Committee in January 1903. The articles were said to be based on a set of principles, which in its most important points stated that the association's shareholders would be only owners of lands that had water rights under the Salt and Verde rivers; that water rights were based on prior appropriation, beneficial use, and appurtenance to land; that stored water created by the dam and "natural flow" water would be distributed and used by the same rules and all lands would be equally assessed for construction and operation charges; that the administration of the irrigation project would be centralized in the association, subject to the control of its members; and finally that the association would guarantee the repayment of the project construction costs. The articles established the par value of the shares at \$15, with each share representing one acre of project land to be irrigated. Based on the estimate that at least 180,000 acres could be irrigated by the reservoir, \$15 per acre would raise \$2,700,000. But, the estimate was not binding, and the final cost of the project would determine the cost per share. (6)

When the draft articles were presented to the Water Storage Committee, serious disputes arose over some of the provisions. Although a majority report recommended passage, a minority report

5 Arthur P. Davis, "Irrigation Near Phoenix, Arizona," U.S. Geological Survey Water Supply Paper No. 2 (Washington: Government Printing Office, 1897).

6 "Salt River Valley Water Users' Association: Brief on Articles of Incorporation dated May 25, 1903," by Joseph H. Kibbey (Salt River Project Archives [hereafter SRPA])

backed by the Tempe and San Francisco canal companies offered a number of amendments to the articles, which were rejected, and the articles were adopted on January 21, 1902, as written by Kibbey. (7)

The key principle of the minority opposition was the desire to maintain independence and autonomy of the existing canal companies. The minority report suggested that each canal form a division in the new association with its own three-man board of water commissioners. This board would both operate the canal and collect assessments. Most important, improvements in each division would be paid for only by the members of that division, and prior rights under the older canals would be protected from dilution. The minority position reflected the concerns of many of the older water rights holders in the valley. These farmers were essentially satisfied with the water delivery system. Farmers under the Tempe Canal were paying about fiftycents per acre per year for water, while "less favored" areas of the valley paid three times that much. They feared that any expansion of irrigated acreage would lead to a reduction of the amount of water available for prior appropriators. They also felt that their well-established and very valuable farms would be the principal security for the project, while land speculators and new homesteaders would be the principal beneficiaries. (8)

The minority interests tried repeatedly to impress their demands on the Secretary of the Interior and representatives of the Reclamation Service, but were told that any changes in the articles would have to come through the Water Users Association. For the next several months, as the association was trying to sign up farmers, the Tempe farmers continued to try to carry the minority arguments to the Secretary of the Interior. For these efforts, the company, and especially Dwight B. Heard (who had bought the Wormser lands and San Francisco Canal in 1900), were alternately vilified and cajoled by valley civic leaders and editorialists. But the Tempe landowners were pursuing an independent course to assure their water supply. Farmers with water rights that did not join the Water Users' Association would still be entitled to "normal flow" water (water that would have come down the river if the dam were not built) delivered through the canals, though they would get little or no water in times of drought. The Tempe Canal shareholders wanted to have their water stored in the reservoir and distributed to them when needed, and even agreed to

7 Earl Zarbin, "Dwight B. Heard: 'A Public Enemy'" (manuscript, n.d., SRPA), pp. 407. The organization was known as the Salt River Valley Users Association (SRVWUA); the dam, canals and allied features, known as the Salt River Project were built by the U.S. Reclamation Service (USRS), and operated by them until 1917, when the SRVWUA took over operating responsibility. Title to the systems remains in the United States.

8 Phoenix Enterprise, February 10, 1903; Minority Report, Salt River Valley Water Storage Committee, and Amendments Offered by the Minority of Salt River Valley Water Storage Conference Committee in Support of Their Report, January 17, 1903 (SRPA).

join the Water Users Association, if the Secretary agreed to the conditions which had already been rejected. However, the government insisted that it would deal only with SRVWUA. (9)

When the sign-up deadline passed on July 13, 1903, only a few of the Tempe farmers had joined the association (the Mesa and Utah canal companies also declined to join the association). The Tempe farmers were immediately forgotten in the excitement over the beginning of dam construction, but the mutual resentment of the Tempe Canal Company and the Water Users Association would color the relationship between the groups for years to come.

BUILDING THE SALT RIVER PROJECT

The Secretary of the Interior officially authorized the construction of the Tonto Dam on October 13, 1903. Work had already begun on some of the auxiliary features, and would continue through 1911. As time passed, the project grew to include much more than the storage dam (renamed Theodore Roosevelt Dam and dedicated by the ex-President on March 18, 1911)> Granite Reef Diversion Dam was completed in 1908, and became the single point of diversion for all the canals on both sides of the river, including those canals like the Tempe which had not joined the association. The government also bought or appropriated all the canals except the Tempe, Mesa and Utah, and made many enlargements and improvements to the system. The government built a power plant for the construction of Roosevelt Dam, which became a permanent hydropower station on completion of the dam; four small hydro plants on the canals; transmission lines to distribute the power; and many of the groundwater pumps which were the primary users of the power in the early years. The final cost of the Salt River Project was \$10,279,191, or approximately \$60 per acre, rather than the \$15 originally estimated. (10)

During the construction, many parallel activities were undertaken to prepare the valley for operation of the irrigation project. The most important of these activities was the adjudication of water rights for almost all the land in the valley, as a result of a lawsuit known as Patrick T. Hurley v. Charles F. Abbott and Others, which was filed in the territorial District Court on January 16, 1905. In this friendly suit, the plaintiff was an early appropriator, and the defendants, approximately 5,000 in number, were every other water user in the Salt River Valley. Certainly, the many different interests and the complexity of issues involved made Hurley v. Abbott the legal and judicial equivalent on the construction of Roosevelt Dam, and its influence on the Salt River Valley has been just as permanent. The decision and decree of Judge Edward Kent (March 1, 1910), building on the Kibbey Decree and other decisions, established the water priority date of virtually all the agricultural land in the valley, both inside and outside the Water Users' Association, and set up a permanent enforcement authority (which, for all practical purposes, has been exercised almost entirely by the USBR and SRVWUA).

10 Karen L. Smith, "The Magnificent Experiment: Building the Salt River Reclamation Project, 1890-1917" (Ph.D. diss., University of California, Santa Barbara, 1982, p. 268.

ATTEMPT TO BUY TEMPE CANAL

The digging of the Western Canal originated in a failed attempt by the Reclamation Service to obtain control of the Tempe Canal. The attempted merger, in turn, derived from the desire of the Tempe Canal shareholders to improve the drainage of their lands, which, by 1910, were becoming severely waterlogged. The geology of the Salt River Valley is generally that of a deep alluvial fill, through which flows a substantial underground flow rises nearer the surface. There are two places in the valley where the flow of the underground river is constricted by underground ridges, which so impair the drainage of water that alkali buildup can destroy the top soil in a few years. One place is the lower end of the valley, where the Salt River meets the Gila River and then flows through a comparatively narrow gap between the Estrella and White Tank mountains. The other area of constriction is across the middle of the valley where an underground ridge extends from the eastern end of the Salt River Mountains north of the Camelback Mountain. This ridge breaks the surface at the Double Buttes and Tempe Butte, as well as the Papago Buttes north of the river. The ponding affect of this ridge in the Tempe area was the reason why Tempe lands were among the first affected by waterlogging when extensive irrigation in the east valley caused the water table to rise nearly to the surface. (11)

In April 1910, Tempe Canal shareholders met to discuss the drainage problem. There were up to 12,000 acres of Tempe land which had serious drainage problems, and while some believed that seepage ditches would be sufficient to carry the water away, others thought that pumping would be necessary, and that this task would require the extensive resources of the government. So, once more, proposals were made to join the Water Users' Association. (12)

Discussions with Hill soon began and, by July, these discussions resulted in a formal offer from the government to buy out the Tempe Canal. The government offered \$157,000 for the entire system including all branch canals, and promised to begin a drainage project as soon as title was transferred. The offer specified that not all the Tempe landowners had to join the Water Users' Association, and if they chose not to, their water would be conveyed to them on a fee basis. However, Hill made it clear that all interest in the Tempe and branch canals must be sold to the government -- the U.S. would not share ownership of any canal. Furthermore, he said, at least seventy percent of the Tempe district's 24,000 acres would have to join the Water Users' Association, or the government offer would be withdrawn. (13)

11 For an extensive discussion on the hydrology of the valley, see Willis T. Lee, Underground Waters of the Salt River Valley, Arizona (U. S. Geological Survey, Water Supply and Irrigation Paper No. 136, 1905).

12 Arizona Republican, April 5, 1910.

13 Arizona Republican, June 30, 1910, July 13, 1910, July 16, 1910; Earl Zarbin, Roosevelt Dam, p. 230.

At the same time, there was the beginning of a movement of farmers in the southern part of the district who independently joined the Water Users' Association, so that they could receive stored water. The valley booster element, which was always inveighing against the Tempe Canal Company, made much of the decision by H. C. Yeager and others to join the association and receive their water from laterals off the Consolidated Canal.

"There is so little natural flow of water in the river now," said Mr. Yeager, in speaking of the 'new epoch,' as he terms it, 'that under the present conditions we would get a run of water . . . once a month or so. I went to Mr. Hill and asked him, "How much water can I get if I sign up and pay up," and . . . he said "All you want Mr. Yeager and when you want it." I could hardly realize that we had reached that blissful day.' (14)

Before the offer was made for the Tempe Canal, Hill had surveyed the canal properties both to determine their value, and to gauge the drainage problem. At the same time, he had polled Tempe landowners and concluded that the owners of 17,000 acres were "willing" to sign up in the project. Certainly, the government was eager to have them. First of all, the early priority of most Tempe water rights meant that they would add considerably to the stored water, since their water had to be allowed to "pass through" the dam, if ordered. And their land would add thousands of acres to the assessment rolls of the project. Furthermore, the Tempe system represented a barrier to the delivery of water to valuable project lands west of it, in south Phoenix. If the government could not acquire the Tempe system, or at least the Wormser extension, it would be faced with digging parallel canals to reach south Phoenix. (15)

However, there were two factors which caused many Tempeans to question the government proposal. First, their current irrigation costs were remarkably low. In the 1910 fiscal year, the Tempe Irrigating Canal Company served 22,510 acres for a total maintenance assessment of \$8,696, or about forty cents per acre. It was expected that assessments under the project would be about \$1.80 per acre. Second, there was adamant opposition of many, if not most, shareholders to joining the government system. All the shareholders knew that some of their neighbors would never sell their interest to the government, and that the government would insist on complete ownership. There was nothing to prevent a Tempe Canal shareholder from signing up with the Water Users' Association, but as more shareholders signed up, maintenance costs continued to rise for the remaining Tempe shareholders. This could result in the devaluation of Tempe Canal stock, which represented a considerable investment for most farmers. Though the boosters asserted that Tempe shares could later be cashed in if the canal was finally sold to the government, in fact, subscribing to the Water Users' Association individually amounted to forfeiture of the investment in the canal.

14 Arizona Republican, June 13, 1910.

15 Hill to Newell, June 28, 1910, from Earl Zarbin, Roosevelt Dam: A History to 1911 (Phoenix: Salt River Project, 1984) p. 230.

On July 25, the Tempe Canal shareholders met to consider the offer. Many spoke in favor of joining the project for the good of the community and the long-term value of their land, and others stated that without united action, piece-meal defection would make the canal economically untenable. It was stated that the value of a Tempe Canal share had already declined from \$8,000 to \$1,200 since the government offer. Yet, most in attendance seemed to recognize that there was an untractable faction among them. W. J. Kingsbury said that "there are half a dozen stockholders . . . who will not sign up or sell their shares in the canal under any circumstances. They came here in an oxcart and they are still in one; you can't get them to come out and take an airship." A vote was called, and though the shareholder vote was 36 to 22 in favor of the sale, in terms of shares the vote was 14-1/2 for and 19-1/2 against; and 138 shareholders (representing approximately 75 shares) did not vote. (17)

That was as close as the Tempe Canal Company came to selling the canal at that time. At the company's annual meeting in September, the issue of joining the project to obtain drainage works was again raised, and it was decided that the company would pursue its own solution to the drainage problem. A final vote on selling the canal was never taken. Although Hill stated that large blocks of Tempe land were signing up for the project. In fact, 1,850 acres of Tempe Canal land were signed to the association by the end of July, but, after that, only 160 more acres were signed up in the next five and one-half years. All the lands that joined the project were in the southeast corner of the Tempe district, and were served by laterals off the Consolidated Canal. (18)

RECLAMATION SERVICE CONSTRUCTION, 1911-1912

Frustrated in his attempt to buy the whole Tempe Canal, Hill made an offer to buy the Wormser and Kyrene branches, which were the most crucial of the Tempe branches for reaching south Phoenix. The government plan was to dig a feeder from the Consolidated Canal in Mesa, west to where it would join either or both these canal, which would have to be widened. It was thought that the government's offer for the Wormser amounted to about \$10,000. The owners of the Wormser (under the Tempe Canal, the branches were owned by the farmers they served) immediately made a counter-offer that they retain the canal but allow the government to expand it to carry association water. (19)

16 Arizona Republican, June 30, 1910, September 26, 1910.

17 Arizona Republican, July 26, 1910.

18 Arizona Republican, September 25, 1910, July 28, 1910; "Salt River Project, Arizona, Final History to 1916," vol. 3, p. 491 (SRPA).

19 Arizona Republican, December 23, 1910; December 30, 1910.

Hill wrote to the Director of the Reclamation Service, asking if the department would still "care to consider a proposition" of owning either of these canals "in common with a few other individuals," with the government owning about three-fourths of the stock. Hill knew that to construct the canal across the low-lying and waterlogged lands of south Tempe would involve constructing a ditch "high out of the ground," and urged government to "exhaust every means to acquire possession of these canals, or either of them, rather than be compelled to build a new ditch in this locality." Evidently, the government declined, for by the first of February there was a crew in the field surveying a canal parallel to the Kyrene. (20)

During the spring of 1911, government crews began digging the Western Canal from both ends toward the middle, while negotiations continued with the Kyrene Canal owners. One the west end (Division 2), the government began at the west line of Section 32 (T1N R4E), and worked upstream, paralleling the Wormser Canal on its south side (see HAER Photo No. AZ-22-21). From this foot, the canal would not serve south Phoenix without a further extension or a crosscut to the San Francisco Canal. On the east end, digging began on Division 1, working from the east, and extending and widening the Peck and Pine feeders, which ran west from the Consolidated Canal to the west line of Section 9 (T1S, R5E). The Eureka Ditch off the Mesa Canal also contributed to the system, joining the Peck feeder near its lower end. By mid-summer, the government had given up its attempt to buy the Kyrene Ditch, and had secured right of way for its parallel canal on the north side of the existing one.

In conformance with its general upgrading of the irrigation distribution system which it owned, the Reclamation Service engineered all the major structures on the Western Canal, such as drops, turnouts, bridges and siphons, and constructed them of concrete [see Tables 1 and 2]. Some of the most complex works resulted from the need to go over or under the Tempe Canal, and its Wormser and Kyrene branches. HAER Photographs No. AZ-22-2 and AZ-22-3 show the Western Canal crossing the main Tempe Canal in Section 12 (T1S, R4E). HAER Photograph No. AZ-22-19 shows the connection of the Wormser Branch to the Tempe Canal (in Section 2, T1S, R4E), and a metered connection with a government waste ditch which fed the Wormser. HAER Photograph No. AZ-22-20 shows the crossing of the Tempe and Western canals (also Section 12), and the complications of two separate systems of laterals, interconnected supply, and roads along section lines. HAER Photograph No. AZ-22-18 shows drawings for a siphon for a crosscut lateral which ran under the Wormser.

Two descriptions survive of the actual work of digging the canal. In June 1911, there were 170 men at work on the project, "of all colors and nationalities," along with 165 head of stock. In one week in June, working eight-hour days, this force excavated 11,808 cubic yards of dirt at a cost of nine cents per yard, "said to be the least expensive work of the sort ever done in this

21 Arizona Republican, June 25, 1911; Salt River Project, "History of the Project for the Calendar Year 1912."

valley." In contrast, a separate account describes the difficulties of blasting out or working around rows of cottonwood trees, and of building up the canal banks along the north side of Kyrene Canal. As Supervising Engineer Hill had foreseen, it was necessary to build up the banks to seven and one-half feet above ground level, the dirt being taken from a borrow pit on the north side of the right of way: "This soon exposed the borrow pit to the seepage water which in this district lies near the surface and soon converted the pit into one great mud hole in which the horses would sink up to or above the knees." (21)

In October, the canal was nearing completion when funds ran out. The sudden shortfall in funding was undoubtedly exacerbated by a complex dispute between the water users and the Reclamation Service. Since 1904, the government had been building and operating the project, charging fees only for operation and maintenance. Repayment would not begin until the project was officially completed and turned over to the Water Users' Association. While everyone knew that the project had grown considerably in scope since the original estimate of under \$3 million, no one knew just how much the final bill would be. By 1911, it became apparent that the cost would probably exceed \$9 million, or over \$50 per acre. Almost all the work had been completed, except for several of the power plants and canals (including the Western Canal). As the end of the project neared, the farmers were faced with the beginning of the ten-year repayment period prescribed by reclamation law. Many of these farmers had bought their land from large landowners at inflated prices after the project began, and would have great difficulty in making the payments on the project, for which their land was pledged as security. This impending disaster produced two responses among the Water Users' Association members. One was to seek an extension of the repayment period from ten to twenty years, which would require an act of Congress (the SRVWUA Board of Governors and local politicians were pursuing this effort in Washington). The other response was to blame the Reclamation Service for fraud and inefficiency which had unnecessarily increased costs. The latter response was in part a reflection of local and national political problems the Service was having over its management of the reclamation program and its relation with Congress, and other federal departments, as well as with the settlers who were its nominal clientele. These matters worsened in 1911 and 1912, leading to a number of investigations of the Service. (22)

In the Salt River Valley, there were, by March 1912, "floating about the valley many indefinite charges of waste and extravagance," as a report of local Reclamation Service officials noted. One of the rumors maintained that three canals had been built and abandoned on the south side, which was not true, but was supposed to refer to the unfinished sections of the Western Canal. (23)

22 Karen L. Smith, "The Magnificent Experiment," pp. 212-222.

23 Chief Engineer, et al. to Director, USRS, March 28, 1912 (Secretary's Box 218-41, SRPA).

TABLE 1

SPECIFICATIONS:
 USRS CONSTRUCTION OF THE WESTERN CANAL, 1911-1912

1. CANALS

<u>Canal</u>	<u>Length, Miles</u>	<u>Capacity Sec/Ft</u>	<u>Width, Feet</u>	<u>Depth, Feet</u>	<u>Yardage Excavated</u>
Peck Feeder	4.5	86	8	3	24,983
Peck-Eureka	1	130	9	4	8,660
Pine Feeder	1.5	60	6	2.8	4,800
Division 1	4.5	261	25	3.5	98,273
Division 2	<u>3.7</u>	200	20	3	<u>56,772</u>
Totals	15.2				193,488

2. STRUCTURES

<u>Canal and Structure</u>	<u>Paving Sq Yds</u>	<u>Concrete Cu Yds</u>	<u>Excavation Cu Yds</u>
Peck Feeder			
7 turnouts with drops	539	62.2	1089
2 drops	124	8.7	245
Headgate	70	29	188
Peck Eureka Feeder			
Junction	47	20	135
Turnout	75.5	11	136
Pine Feeder			
Turnout	52	5.5	30
Lateral Structure	49.6	3.5	20
Main Canal, Division 1			
Head Structure	272	75.3	350
3 Turnouts	300	71.5	280
1 drop	97	8.7	20
6 siphons	5.4	51.6	370
Tempe Canal Siphon	125	114	950
Main Canal, Division 2			
Division Gates	103	20	50
Siphon Under Railroad	69.5	53.6	323
2 Siphons		5	195
2 Waste Ways		3.5	60
Clemans Lateral Structures			
4 Structures	28	125	112

SOURCE: Salt River Project, Project Histories, 1911-1912

TABLE 2

COSTS AND EXPENSES
USRS CONSTRUCTION OF WESTERN CANAL, 1911-1912

1. RIGHT-OF-WAY PURCHASES

<u>Grantor</u>	<u>Location</u>	<u>Acreage</u>	<u>Price</u>
M. C. Swallow	N 1/2 Sec. 8, T1S R5E	6.14	\$ 771
Neils Petersen	Sec. 8, T1S R5E	3.33	700
Leonard Mets	Sec. 8, T1S R5E	1.56	189
T. A. Knox	NE1/4 Sec. 7, T1S R5E	1.51	227
H. Dobson	Sec. 7, T1S R5E	1.51	126
Martin/Dobson	Sec. 7, T1S R5E	1.51	227
C. A. Saylor	Sec. 5, T1S R5E	3.62	651
Packard Inv. Co.	NE1/4 Sec. 12, T1S R4E	4.23	740
Myers Heirs	NW1/4 Sec. 12, T1S R4E	5.45	954
Elling Olsen	NE1/4 Sec. 11, T1S R4E	6.08	1154
M. Barkdoll	NW1/4 Sec. 11, T1S R4E	7.69	1460
Mocur-Pafford Co.	NE1/4 Sec. 10, T1S R4E	2.26	430
H. P. Tude	SW1/4 Sec. 3, T1S R4E	8.48	550
John Jungerman	NW1/4 Sec. 3, T1S R4E	3.38	350
Hughes, et al.	NW1/4 Sec. 3, T1S R4E	1.05	100
Mons Ellingson	SE1/4 Sec. 33, T1N R4E	3.46	300
E. W. Craig	SE1/4 Sec. 33, T1N R4E	1.26	400
J. H. Henness	SW1/4 Sec. 33, T1N R4E	2.32	350
Robert Rudlen	NW1/4 Sec. 33, T1N R4E	1.58	117
J. P. Jansen		.52	120

2. EXCAVATION COSTS

Yardage Excavated: 199,558 Cubic Yards (Cu Yds)
Length: 16.21

<u>Classification</u>	<u>Amount</u>	<u>Unit Cost (per Cu Yd)</u>
Foreman	\$ 1,285	\$.0065
Plow and Scraper, Men	16,011	.0802
Plow and Scraper, Stock	17,211	.0862
Finishing Men	4,234	.0212
Engineering and Superintendence	5,838	.0292
Camp Expense	1,737	.0087
Equipment Depreciation & Repairs	1,292	.0064
Proportion of General Expense	<u>3,434</u>	<u>.0173</u>
Totals	\$51,040	.2557

SOURCE: Salt River Project, Project Histories, 1911-1912.

While many Water Users' Association members perceived that this interests were served by petitions and complaints against the USRS, the farmers of south Tempe and south Phoenix, who were sitting on unpatented homesteads awaiting the completion of the Western Canal, had different interests. USRS Chief Engineer A. P. Davis wrote that the completion of the Western Canal was the "most urgent work for which no provision has been made." Overall, the Service estimated that the canal system was then sufficient to serve 160,000 acres of the potential 240,000 irrigable acres of the project. Director F. H. Newell, however, ordered that in the existing climate "all further expenditures (on the Salt River Project) should be made out of the returns from the project," a policy which "should be kept prominently in sight." Reclamation Service work on the Western Canal was not resumed until September 1912, and was completed a few months after that. It appears that the necessary funding to complete the Reclamation Service work came from applying a refund of SRVWUA freight costs to the job. (24)

CONTRACTOR CONSTRUCTION, 1912-1913

The funding problem which led to a year's delay in finishing division 1 and 2 of the Western Canal, inspired South Phoenix farmers and residents to form their own company to extend the canal farther west to serve their lands. In February 1912, the SRVWUA board of governors requested that the Secretary of the Interior devise a plan by which farmers could construct canals and laterals under the supervision of Reclamation Service engineers. Over the next several months, the Reclamation Service worked out such a plan, which resulted in an agreement (signed August 19), by which the newly-formed Western Canal Construction Company, Inc. would supply all labor and materials for the western extension of the canal, in return for credit on water deliveries for a maximum of three years. (25)

The Western Canal Company was responsible for the acquisition of right of way and construction of divisions 3 through 6 of the canal, which included eight miles of main canal, beginning at the end of the government's Division 2 on the west line of Section 32 (T1N, R5E) and running west along the highest possible gravity line before turning southwest and terminating in Section 1 (T1N, R4E). The canal ran parallel to and just south of the Wormser Canal. The work also included construction of laterals, turnouts and bridges. HAER Photograph No. AZ-22-22 shows a map of the right of way of Division 4.

Work on Division 3 by the Western Canal Company began on September 28th and proceeded concurrently with the USRS completion of Divisions 1 and 2 and the feeders. Government surveyors ran center lines and cross sections of the canal bed, and staked grades and bridges. Survey work was completed by the first week of December, and excavation was finished several

25 Western Canal Company Contract, Salt River Project, Arizona, "History of Irrigation Canals to 1916," p. 229 (SRPA).

weeks after that. The first delivery of water took place on February 16, 1913. Structural work was completed in March. (26)

In the 1913 and 1914 irrigation seasons, it was determined that the supply through the Peck and Pine feeder canals was approximately 160 cubic feet per second (cfs) short of what was needed to satisfy the requirements of the Western Canal. It was decided to build a third feeder, following the line of the Wallace Ditch, which ran parallel to the Peck and Pine, and between them. The first plan was to have government forces build the entire structure, but this was "strenuously" objected to by the Water Users' Association, which insisted that most of the work be contracted. Contract was let to S. J. Rhodes for \$14,132, and construction began September 26, 1914. Subcontractor for the concrete and bridge work was the Arizona Construction Company. The contractor had considerable trouble with drainage on this canal, which was aggravated by the fact that he dug from the head (east end) of the canal to the foot, so that he was always digging in the lowest part of the canal. If he had gone the opposite way, the water would have drained into the completed section of the canal. In the end, Rhodes estimated that he lost \$6,000 on the construction of the canal, due to water accumulation. The canal was completed on January 26, 1915. (27)

In January 1916, as the construction water credits were about to expire, Western Canal Company shareholders sought an extension of the three-year credit period. They maintained that their investment in the canal far exceeded the three year's water service credit required by the contract, for several reasons. First, the irrigable area under the Western Canal had been reduced from 13,000 acres to 9,000 by the Board of Survey, which, in 1914, determined the official boundaries of the project. The Western Canal Company maintained that it had incurred unnecessary expense in building the canal to irrigate 13,000 acres. Second, it was contended that for the first two years of service, the water supply had been inadequate, due to the inadequate size of the feeder system from the Consolidated Canal. In the 1912-1913 irrigation season, the 7,545 acres cultivated under the Western Canal received a total of 11,900 acre feet of water, a duty of only 1.58 acre feet per acre. In the Salt River Valley at that time, a duty of 3.5 to 4 acre feet was considered the minimum for successful cultivation. In the 1913-1914 season, the duty on the 8,924 acres cultivated was 1.89 acre-feet, and, in the 1914-1915 season, after completion of the Wallace Feeder, the duty on 9,061 acres finally reached an acceptable level of 3.53 acre-feet per acre. On this basis, the Western Canal Company calculated that the water they actually received in return for the canal cost them \$1.38 per acre-foot, as opposed to a typical cost of fiftycents per acre-foot on the rest of the project.

The company made their case to the local and Washington offices of the Reclamation Service, as well as to the Board of the Water Users' Association. The Reclamation Service refused to

26 Tri-Monthly Reports, 1912 (Secretary's Files C-1, SRPA)

27 Salt River Project, Arizona, "History of the Project for the Calendar Year 1914 (Supplemental History," pp. 28-34 (SRPA)

alter the contract except on petition of the Board of the Water Users', which was not forthcoming. SRVWUA President John Orme was opposed to any extension of credit. (28)

THE HIGHLINE CANAL AND PUMPING PLANT

In October 1909, a meeting was called in the office of Dwight B. Heard of all farmers situated above the high line, then marked by the Wormser Canal on the slopes of the Salt River Mountains. The purpose of the meeting was to discuss the means to obtain water for the approaching irrigation season. The following spring, in April 1910, another meeting was called. The Arizona Republican stated that "it has always been firmly believed by those who have taken up land in that locality that the government would eventually come to their rescue and supply pumped water for the irrigation of their lands." This reasoning was said to have been fortified by recent talk of draining the Tempe lands by pumping them out. It will be remembered that this was the period when the purchase of the Tempe Canal by the government seemed imminent, and one of the conditions being discussed was the quick relief of the area by drainage pumping. The water which the Tempe farmers were anxious to get rid of was coveted by those who had at that time no water at all. Upon the advice of Supervising Engineer Hill, the meeting elected one of its members, Roy S. Goodrich, to go to Washington to press the highliners' case before the Secretary of the Interior. It was thought at the time that there were as many as 15,000 irrigable acres on the east, north and west slopes of the Salt River Mountains, and the soil was said to be a sandy loam ideal for citrus trees. (29)

However, nothing further was accomplished toward a high line canal until February 1912, when the SRVWUA board made its appeal to the government to allow farmers to construct their own ditches. In March, Goodrich and Heard met with Davis, Hill, and members of the SRVWUA board to discuss the Highline and Western canals. A few days later, on March 29, the Highline Canal Construction Company was incorporated, with Goodrich as president; Walter Strong, vice president; John J. Gould, secretary; and C. P. Mullen, treasurer. The capitalization of the company was \$100,000, and sale of stock was limited to members of the Water Users' Association or homestead entrymen under the proposed canal. The purpose of the company was to acquire all land and right-of-way for a canal, laterals and a pumping plant. The company would build the system under the supervision of Reclamation Service engineers, then, upon completion, turn the entire system over to the United States, in exchange for up to three years' credit on assessments. A preliminary estimated by Chief Electrical Engineer O. H.

28 File A-3-1, Application for Extension of Time (Secretary's Box 218-40, SRPA).

29 Arizona Republican, October 27, 1909, April 17, 1910, April 18, 1910.

Ensign of the Reclamation Service put the cost of the plant at \$75,000, including the pipeline, two pumps with electrical motors and transformers, and a pumping building. (30)

On August 22, the company entered into a contract with the United States. This was almost identical to the contract which the Western Canal Company had signed just three days earlier. However, unlike the Western Canal, the Highline Canal was not a simple matter of surveying and digging a ditch. The principal feature of the Highline System would be the electric pumping plant and pressure pipe which would raise water forty feet through a single 54-inch diameter pipe over a mile long. The water would be drawn from a forebay in the Western Canal and pumped by three (rather than two) horizontal, direct-connected pumps through a steel manifold into the concrete pipe. Each pump would supply 9,000 gallons per minute (20 cfs). Check valves at the bottom and top of the pipe would prevent water from flowing back when the pumps were stopped. Each pump was powered by a 150 horsepower, 2,200 volt, 25 cycle motor. Power would be supplied through SRP transmission lines from the newly-completed Roosevelt Dam power plant. HAER Photographs No. AZ-23-23 through AZ-23-25 show plant location, elevation and layout; while HAER Photographs No. AZ-23-26 through AZ-23-28 show manifold, pump, foot valve, and other components. HAER Photographs No. AZ-23-1 through AZ-23-4 show the original plant building, pumps, and motors, as they looked in the early 1950s.

Throughout the fall of 1912, a good deal of time was spent by USRS engineers in preparing drawings and specifications and advertising for bids. In December 1912, contracts were awarded to General Electric Company for the electrical apparatus, and with Perrine Machinery Company for the pumps. Also, in December, the construction of the pipeline was begun by the company of Martin & Gills. (31)

Construction of the Highline Canal went forward on two branches (see HAER Photograph No. AZ-23-22). The northern branch ran about ten miles along the east and north side of the Salt River Mountains, from one-half to one mile above the Western Canal. The southern branch ran toward the southeast about four and one-half miles. Ninety-two thousand yards of material was excavated at a cost of \$17,500 by Toohey and Sons Contractors. The structural work was by Arizona Engineering and Construction Company.

Construction of the pump building was begun in February 1913, by Martin & Gillis. At the same time, the Highline Construction Company was erecting an 11,000-volt electrical line from

30 Articles of Incorporation of the Highline Canal Company, March 29, 1912 (SRPA); "Power and Pumping System of the Salt River Project, Arizona," report by James M. Gaylor, 1914, p. 149 (SRPA).

31 "Power and Pumping," pp. 149-158; Salt River Project, Arizona, "History of the Project for the Calendar Year 1913," p. 35 (SRPA).

the closest SRP line (at Southern Avenue and Mill Avenue) to the plant. This line was completed March 19, as installation of the machinery was just underway. In setting up the machinery, emphasis was placed on getting at least one pump in position to pump water into the pipeline for a 20-day pressure test for leaks, as required in the specifications. One pump was started April 11 to fill the pipe, and a severe water hammer was reported when the pump was shut off. Several days later, tests of the pump confirmed that when the pump was switched off, the sudden cessation in the movement of water caused the water pressure in the pipe to go through a series of oscillations from the static head of 18 pounds per square inch (psi) down to virtually no pressure, then up to 30 psi. The pressure continued in 12 second cycles of gradually diminishing intensity. This problem set off a flurry of correspondence because, as one Reclamation Service engineer noted "I wish that we had gone into the discharge pipe a little heavier, but when it was being built I did not give it as much thought as I should. We have all of our stuff, so that it will stand 100% over (maximum) pressure, while (this) pipe was built for only 25% over pressure. Pump casings tested at 50 pounds." (32)

The engineers agreed that the water hammer was caused by the continued uphill movement of the water column after the pump shut off, until its kinetic energy was expended. This action was possibly augmented by a slight delay in the closing of the foot valve, or by elasticity of the pipe in response to pressure change. The junior engineer, James Gaylord, suggested a large standpipe be attached to the pressure pipe to provide a means of supplying the water to keep the column smoothly in motion until its kinetic energy was dissipated. However, his superior, Chief Electrical Engineer O. H. Ensign, opted for a flywheel which would cause the pump to slow down more gradually, preventing the drop in pressure caused by a sudden stop. This would be a superior solution, he said, because it would eliminate the cause of sudden changes in pressure, while a standpipe would merely cushion the effect of the pressure changes. It was also the cheaper solution, since flywheels for the three pumps would cost about \$750, as opposed to \$2,000 for the standpipe. A flywheel of four feet diameter and weighing 700 pounds was drawn up, bid on and ordered for use in tests on one of the pumps. (33)

Further tests had resulted in the conclusion that the water hammer was greater with two pumps than with one. So, until the flywheel could be tested, only one pump was run. Regular water service to the Highline Canal began June 16, 1913, and it was felt that with each unit pumping 20 cubic feet per second, at least two pumps would be required to satisfy demand. The need was aggravated by the fact that the newly-dug canals consumed considerable water in excess

32 "History of the Project for the Calendar Year 1913," p. 55; "Power and Pumping," p. 151; Gaylord to Chief Electrical Engineer (hereafter CEE), April 19, 1913; CEE to Gaylord, April 22, 1913 (SRPA).

33 Gaylord to CEE, April 22, 1913; CEE to Gaylord, April 23 (two letters); CEE to Harris, April 25, 1913 (all SRPA).

seepage in the first few weeks of operation. The flywheel was first tested the same day, but it was a disappointment, in that it failed to materially lengthen the stopping time of the pump. This may have been due to the fact that the centrifugal-type pump, by its design, had a sharp dropoff in output below its critical speed range. Although flywheels were ordered for the other two motors, it was soon decided that the only thing left to do was build the standpipe. The local engineers must have felt that their design and execution of the plant was, in some way, lacking, for they tried to obtain approval to spend government funds for the work, but this was denied by Washington. The Highline Canal Company did not agree to pay for the standpipe until October, and the engineers were fearful of running more than one pump at a time, so the first summer, the entire system was supplied by one pump, producing 20 cfs. (34)

In the meantime, problems had also developed with the efficiency of the pump. These problems are more indicative of the practical problems the engineers faced than anything else. A test in early June seemed to indicate that the pumps had an efficiency of 55 percent, far less than the 78 percent required by the machinery contract.

Tests of pump efficiency also revealed problems with the very process of testing. In the first place, the farmers were now well into the irrigation season, trying to stretch the output of the single pump to as many acres as possible, so any interruption in service was unwelcome. Second, the engineers were having problems obtaining properly calibrated instruments for testing electrical current, water pressure and water flow, which limited their ability to make fairly fine judgements of efficiency (one engineer expressed the wish that he could have the use of rated meters that were not "knocked around the country on motorcycles as are the ones we have to depend on.") Even when the testing equipment was available and operating, there was some question whether the engineers knew exactly what they were doing in constructing this plant. There were some obvious errors -- after ordering the flywheels at 48 inches diameter, it was necessary to chip out the pump house wall slightly to get them to fit on the motors. Other problems simply revealed a lack of experience in making water move uphill. These engineers were familiar with the building of hydropower generating plants, groundwater pumps, and even cableways, but references in their correspondence to past problems encountered and solved lacked any mention of the pumping of water through a pressure pipe. (35)

After the engineers had fairly well decided that the pumps were delivering only 65 percent efficiency at best, a representative of the manufacturer, Kingsford Foundry & Machine Company, was summoned from Oswego, New York, at Kingsford's expense. The representative

34 Engineer in Charge of Power Division (hereafter EPD) to CEE; June 20, 1913; CEE to Gaylord, April 22, 1913; Director to Supervising Engineer, August 12, 1913; Goodrich to Hill, October 14, 1913 (all SRPA).

35 EPD to CEE, June 5, 1913; CEE to EPD, June 20, 1913; CEE to Harris, May 23, 1913; EPD to CEE, November 4, 1913 (all SRPA).

turned down the tips of the impeller vanes, the results of which adjustment was inconclusive. He also suggested that the entire problem was caused by air in the pump, due to the suction pipes not being submerged deep enough in the intake canal. Although Engineer in Charge of Power Division Irving C. Harris thought this a "preposterous" explanation, later tests confirmed that it was probably correct. The Kingsford man also contended that the engineers were measuring the pressure and vacuum in the wrong place, which accounted for their low readings. Although this was also briefly disputed, the engineers finally decided that they could not clearly show that the pumps were not meeting the contract specifications for efficiency.(36)

FURTHER WORK ON THE HIGHLINE

The standpipe was completed in January 1914, and thereafter the performance of the plant was considered satisfactory. The total cost of the plant turned over by the Highline Canal Construction Company was \$56,990, considerably less than the Reclamation Service's original estimate of \$75,000 for a two-pump plant. Within a few years, however, the capacity of the pumps was found to be inadequate at the height of the irrigation season and, in 1918, a fourth pump was added, which had a higher horsepower and output rating (200 horsepower and 33 cfs), but was otherwise identical. The pump building and manifold pipes were extended to include the new pump. Total cost of the new installation was \$11,670, which was paid for by the Highline Canal Construction Company, which was still in existence. Even then, the water supply was found to be not entirely sufficient, and a new pipeline was considered. During the summer of 1920, two temporary pumps were added, which pumped additional water into the surge chamber, and this increased the supply to a satisfactory level. In 1921, new work on the Highline system was done with the view of permanently eliminating supply problems. This involved increasing the delivery capacity of the Western Canal to the pump plant by enlarging several siphons. In addition, three air vents were installed at intervals in the pipeline. The three older pumps were rebuilt to provide 28 cfs, and given new 250 horsepower motors. The new plant delivered a total of 100 cfs when all pumps were operating. Cost of the rebuilding was \$23,140, paid out of association funds, but in the summer of 1921, for the first time all irrigation demands were met without complaint. (37)

This may be considered the completion of the construction on the Highline pumping plant. Total cost of the three major phases of work (1913, 1918, 1921) was \$91,800.

36 EPD to CEE, November 4, 1913 (SRPA); "Power and Pumping," p. 154.

37 U.S. Congress, House, 18th Annual Report of the Reclamation Service, 1918-1919, 66th Cong., 2nd Sess., Doc. no. 430 (Washington: GPO, 1919) p. 81; Salt River Project, Arizona, "History of the Project for the Irrigation Year 1918-1919," p. 13; "History of the Project for the Period October 1919 to September 1920," p. 161; "History of the Project for the Periods October 1920 to September 1921," pp. 226, 249-250.

THE CANALS IN A CHANGING LANDSCAPE

In 1952, a new Highline pumping plant was built on the west side of the Western Canal, as part of a project-wide, federally-financed rehabilitation and betterment program. The new plant had a short concrete feeder ditch and eight freestanding pumps attached to an above-ground steel manifold (see HAER Photographs No. AZ-23-1 and AZ-23-5 through AZ-23-12). The installation of equipment was begun in September 1952, and completed by June 1953. The new pumps had a total capacity of 125 cfs and were 30 percent more efficient than the old ones, which resulted in yearly savings of \$24,000 in power costs. The cost of the new plant was approximately \$200,000. (38)

The Western and Highline canal systems also underwent considerable renovation under the rehabilitation and betterment program. Typical improvements included concrete lining of the canals and lining or piping of many laterals, replacement of wooden control structures with concrete, and the installation of telemetry equipment of many pumps and gates for instant, centralized control. Since the late 1940s, the Salt River Valley has been experiencing rapid and almost continuous population growth, in which many of the most productive farmlands of the Salt River Project have been converted to residential neighborhoods and commercial developments. This has led to a change in the purpose of some SRP canals, as the delivery of water to city water filtration plants for municipal water systems became more important. In addition, large parts of the urbanized area still receive flood irrigation through a system of laterals which, though largely piped, follows the same lines as the original farm laterals. Those lands, though now residential, retain their Kent Decree water rights, which qualify them for relatively cheap water from the Water Users' Association (now known simply as the Salt River Project).

The Highline and Western canals still flow for the most part in the same banks dug with such trouble out of the water-soaked land before the World War I (though the groundwater level has long since receded due to heavy pumping). The area under these two canals has been somewhat slow to urbanize as the main directions of development have been to the north, west and east. In 1989, the cities of Chandler and Mesa proposed a joint development of a canal-side park area along the Western Canal, east of Dobson Road. This recreational use of the canals will add an aesthetic element to their value, which may help to ensure that they will continue to be major features of the Salt River Valley environment.

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